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COMPARISON OF FOUR INSECTICIDES, INCLUDING DDT, IN MINERAL OIL FOR CONTROL OF THE CORN EARWORM IN DENT SEED CORN

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Inbred lines of corn used in making commercial single crosses are often severely damaged by the corn earworm (Heliothis armigera Hbn.), as well as by diseases that develop in the ears following earworm attack. The extent of such damage is dependent upon the susceptibility of any particular line to earworm and disease, and also upon the number of larvae entering the ear and the time of their entrance.

In Illinois the earworm may cause damage to corn either in the roasting-ear stage or in the maturing ears. Diseases are more often associated with the first type. Loss from the second type is due to feeding by the larvae on the outer parts of the kernels, or to their burrowing beneath the kernels so that they are lost in harvesting. Kernels with any appreciable surface feeding must be discarded.

The method recommended by Barber and coworkers (1-4) and Davidson (5) for the control of the earworm in sweet corn grown for roasting ears or for seed is the injection of mineral oil containing pyrethrum, dichloroethyl ether, or styrene dibromide into the silk mass just above the tips of the ears at about the time the silks begin to turn brown. The degree of control obtained by this treatment in dent corn being grown for seed has been questionable. Tests comparing DDT (1-trichloro-2,2-bis(p-chlorophenyl)ethane) with the other insecticides were therefore made at Decatur, Ill., in 1944, in an effort to obtain a greater reduction of worm damage. It was already known, from experiments conducted by Ivy (6), Johnson (7), and Stevenson, Sheets, and Breazeale (8), that DDT is highly toxic to the corn earworm. It was also known that the degree of control from the injection of oil plus an insecticide depends on the length and tightness of the husks as well as on the amount of oil injected. On the other hand, it was known that excessive amounts of oil prevent development of kernels on the tips of the ears. The experiments were therefore designed to take all these factors into account.

Small-Plot Experiment

Eight inbred lines, four long-husked and four short-husked, with husks ranging from loose to very tight, were planted in triplicate. All the plots were planted and cared for by the Bear Hybrids Corn Company on its seed-production farm at Decatur. On the same farm the long- and short-husk conditions were simulated in one inbred line, U.S. 187-2, by planting it in duplicate and clipping back the husks of one planting to the tips of the ears. One replication of all eight lines was destroyed by chinch bugs (Blissus leucopterus (Say)).

Two highly refined mineral oils were used, Bayol (80-90 seconds Saybolt) and Superla No. 13 (120-125 seconds Saybolt). Each insecticide was tested in both oils, in the following concentrations: DDT 2 percent, pyrethrum extract (0.2 percent pyrethrins), dichloroethyl ether 2 percent, and styrene dibromide 1 percent. They were applied at two dosages, 0.6 and 1.2 ml. of solution per ear.

Each plot was 6 hills long, with a maximum of 3 plants per hill. The ears of 3 hills were treated with the insecticide dissolved in Bayol, and the others with the insecticide in Superla No. 13. The number of ears in each replication ranged from 4 to 9, with an average of 6.3. As is shown later, the type of oil did not appear to influence the results, and thus the average size of the sample in each replication that could be used for comparing the various dosages was increased to 12.6 ears.

The corn was harvested at the normal time for gathering seed. Ears from each plot were examined to determine the number of immature kernels per ear damaged by the earworm and disease, and the number of mature kernels per ear damaged by the earworm. The effect of DDT on germination of the seed was also determined. Table 1 summarizes the average percentage of infested ears per plot per inbred and the average loss of kernels on all inbred lines in each treatment and in the untreated checks. It also gives the combined averages of both oils and the two rates of treatment. In table 2 the results obtained from the four insecticides in both oils and at two rates of treatment are averaged according to inbred line and husk type in order to show the effects of length and tightness of husk on control.

Table 1.--Effect of injection of insecticides in mineral oil into silks of dent corn for control of the corn earworm. Small-plot experiment, dosages 0.6 and 1.2 ml. of oil solution per ear, 1944

Treatment	Ears infested		Estimated kernels lost per ear due to--				Living larvae per ear at harvest 1/	
			Earworm and disease in green corn		Earworm in maturing corn			
	0.6 ml.	1.2 ml.	0.6 ml.	1.2 ml.	0.6 ml.	1.2 ml.	0.6 ml.	1.2 ml.
	Percent	Percent	Number	Number	Number	Number	Number	Number
DDT:								
Bayol	16.7	12.3	2.4	2.5	0.04	0.1	0.0	0.16
Superla	17.2	11.4	3.1	2.6	0	0	.025	
	Av. 14.4		2.7		.04		.01	
Pyrethrum:								
Bayol	49.7	49.3	12.2	8.7	1.0	1.8	.36	.25
Superla	51.1	47.0	14.1	8.8	.9	.7	.25	.12
	Av. 49.3		11.0		1.1		.245	
Dichloroethyl ether:								
Bayol	68.1	58.1	15.1	8.8	1.4	2.3	.295	.45
Superla	67.6	58.0	12.0	8.5	.5	1.4	.292	.25
	Av. 63.0		11.1		1.4		.32	
Styrene dibromide:								
Bayol	59.2	35.0	10.7	5.3	.5	0.6	.255	.24
Superla	61.2	49.3	16.4	6.3	1.0	1.7	.248	.20
	Av. 51.2		9.7		1.0		.24	
Checks (untreated)	92.1 2/		19.0		2.3		.35	

1/ Average represents larvae on one replication.

2/ An average of 106.9 ears of each inbred line examined. There were 4 check plots in each replication.

Table 2.--Effects of length and tightness of the husk covering of dent corn on control of the corn earworm by injection of insecticides in oil into the silk. Average of all ears injected with the four insecticides in both oils at both dosages.

Type of husk coverage	Inbred lines	Infested ears			Kernels damaged by earworm and disease		
		Treated	Untreated	Reduction	Treated	Untreated	Reduction
		Percent	Percent	Percent	Number	Number	Number
Long, loose	U.S. 187-2	61.3	97.7	37.3	17.2	39.1	56.0
	Ill. R4 1/	28.0	98.2	71.5	4.0	15.5	74.2
	Av.	44.7	98.0	54.4	10.6	27.3	65.1
Short, loose	Ind. 38-11	53.3	86.9	38.7	10.1	20.1	49.8
	Ill. M14	39.7	81.4	51.2	6.6	15.0	56.0
	U.S. 187-2 2/	68.0	96.4	29.5	21.7	35.6	39.0
	Av.	53.7	88.2	39.8	12.8	23.6	48.3
Long, tight	Kans. K4	6.4	93.5	93.2	.7	11.6	94.0
Long, moderately tight	Ind. Wf9	44.5	87.1	48.9	7.1	18.4	61.4
Short, moderately tight	Ill. Hy	55.2	97.3	43.3	10.0	20.6	51.2
Average, all lines		44.6	92.3	51.7	9.7	22.0	55.9

1/ Although classed as loose-husked, the husk sticks to the ear surface in places until maturity.

2/ Husks clipped back to tips of ears.

Commercial-Scale Experiment

The Bear Hybrids Corn Company also treated by injection the ears on two rows in each of two commercial foundation seed fields with 2 percent of DDT in Superla No. 13 oil and on two other rows with 3 percent of dichloroethyl ether in the same oil. Two rows in each field were left untreated as checks. The treatments were made by the regular crew in the course of their application of dichloroethyl ether in oil to these fields. The solutions were injected at the rate of 0.75 ml. per ear.

At harvesttime five 25- to 30-ear samples were taken from each area and examined in the same manner as in the small-plot experiment. In addition the company processed the seed from each area separately, and determined the relative amounts of labor involved in sorting the ears, as well as the approximate amounts of damaged corn. The results are shown in table 3.

Table 3.--Effect of injection of insecticides in mineral oil (Superla No. 13) into silks of dent corn for control of the corn earworm. Commercial-scale experiment, dosages 0.6 and 1.2 ml. of oil solution per ear, 1944

Insecticide	Infested ears 1/	Estimated kernels lost per ear due to --		Living larvae per ear at harvest	Germination of sound kernels	Yield of corn		Processing time, removing damaged kernels per bag
		Earworm and disease in green corn	Earworm in maturing corn			Damaged ears	Undamaged ears	
	Percent	Number	Number	Number	Percent	Bags	Bags	Minutes
DDT	24.8	2.2	0.5	0	96.9	1.50	4.75	20
Dichloroethyl ether	82.3	9.9	3.1	.26	96.2	4.00	2.00	40
Check (untreated)	93.6	11.5	4.3	.23	96.2	5.00	.33	60

1/ 56 percent of the ears had small larvae established in them before treatment.

Discussion

DDT was the only insecticide which protected the corn until harvesttime. DDT in mineral oil gave almost complete control of the corn earworm in both the green and the maturing stages of the corn ears in both experiments. Some of the slight damage shown undoubtedly resulted from larvae already established before the insecticide in oil was applied. In the small-plot experiment most of the damage in the DDT plots occurred in one inbred line, U.S. 187-2. Pyrethrum, styrene dibromide, and dichloroethyl ether were all less effective than DDT. Styrene dibromide ranked second to DDT.

In the small-scale experiment the 1.2-ml. dosage was, in general, superior to the 0.6-ml. dosage. The greatest increase in control resulting from the larger dosage occurred with styrene dibromide in long, loose-husked lines such as U.S. 187-2. None of the insecticides adversely affected germination.

The 0.6-ml. dosage did not appear to reduce the development of the tips of the ears appreciably, whereas the 1.2-ml. dosage caused some loss of tip kernels, especially in the tight-husked line Kansas K4. This loss is thought to have been due to the oils, as none of the insecticides tested appeared to retard kernel development. The dosage of the solution should be limited to 0.6 ml. in very tight-husked lines and increased in lines with loose husks. The best control was obtained in the long, tight-husked line K4. The reduction in numbers of kernels damaged was somewhat greater in the long than in the short, loose-husked lines. Tightness of husk seemed more important than length for a high degree of control. There did not appear to be any significant difference in the control obtained with the two oils.

In 1944 by far the greatest saving in corn resulted from prevention of the diseases that enter the ears following earworm attack. This does not apply to those diseases that enter the ears through the shank.

Of the four insecticides tested, DDT appears, at present, to be the most ideally suited for use in controlling the earworm in dent corn grown for seed. This insecticide produced no visible effects on the operators, whereas styrene dibromide is very irritating to some persons.

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